

Item No. 656	Removing existing solid traffic stripe __ in (mm) wide (<u>type</u>)	Per linear mile (kilometer)
Item No. 656	Removing existing skip traffic stripe __ in (mm) wide (<u>type</u>)	Per gross linear foot (meter)
Item No. 656	Removing existing traffic markings (type)	Per square yard (meter)
Item No. 656	Removing existing traffic markings—words	Per each

656.5.01 Adjustments

General Provisions 101 through 150.

Section 657—Preformed Plastic Pavement Markings

657.1 General Description

This work includes placing plastic pavement markings or legends according to the Plans and Specifications or as otherwise directed.

657.1.01 Definitions

General Provisions 101 through 150.

657.1.02 Related References**A. Standard Specifications**

General Provisions 101 through 150.

B. Referenced Documents

Manual on Uniform Traffic Control Devices for Streets and Highways

QPL 74

657.1.03 Submittals

Transfer to the Department manufacturer warranties or guarantees for heat-applied preformed plastic marking materials. Ensure that warranties or guarantees state that they are subject to transfer.

657.2 Materials

Select one of the following types of preformed marking material according to the Plans and Proposal:

- Type TR—Temporary Removable Plastic Marking
- Type TN—Temporary Non-removable Plastic Marking
- Type PA —Permanent Plastic Marking
- Type PB—Permanent Patterned Plastic Marking

For a list of sources, see QPL 74.

A. General Requirements for Preformed Pavement Markings

1. Shapes and Sizes

Use markings that conform to the shapes and sizes outlined in the Manual on Uniform Traffic Control Devices for Streets and Highways.

2. Pigmentation

Use white or yellow pigmented plastic according to each marking type.

3. Adhesion

Use markings that can be affixed to bituminous or Portland cement concrete pavements by pressure-sensitive precoated adhesive or a liquid contact cement.

Ensure that marking adhesive adheres to the roadway under normal climactic and traffic conditions.

4. Conformability

Use markings that will mold to pavement contours, breaks, faults, and the like, by normal action of traffic at normal pavement temperatures.

5. Resealability

Use markings containing resealing characteristics that allow the material to fuse to itself or to similar previously applied material under normal use.

6. Glass or Ceramic Beads

Use markings with a layer of glass or ceramic beads bonded to the surface according to the marking type. Type PB contains ceramic beads and glass beads. Types TR, TN, and PA contain only glass beads.

Use glass beads with less than 2% by weight showing any milkiness, scoring or scratching. Use clear, transparent beads that are free from air inclusions and conform to the following:

	Glass Beads	Ceramic Beads
Refractive Index, (tested by oil immersion)	1.50 minimum	1.70 minimum
Uniform Distribution of Spheres	0.75 minimum	0.75 minimum

7. Reflective Intensity

Determine reflective intensity using photometric testing procedures of Federal Specification L-S-300 A, Paragraph 4.4.7.

Ensure that marking types TR, TN, and PA use white or yellow film with the initial reflective intensity indicated in the table below, when measured at the angles shown. See Subsection 657.2.C.2.k for reflective intensity of Type PB.

	White		Yellow	
Divergence Angle	0.2°	0.5°	0.2°	0.5°
Incidence Angle	86°		86°	
Reflective Intensity --candle power per foot-candle per square foot (Candelas per Lux per square meter)	1.00	0.75	0.75	0.50

8. Composition

Use markings made of high-quality polymeric materials and pigments. Ensure types TR, PA, and PB contain the following composition of materials:

Material	Min% By Weight
Resins and Plasticizers	20
Pigments	30
Graded Glass Beads	33

B. Requirements for Temporary Markings (Types TR and TN)

1. Temporary Removable Markings (Type TR)

Use temporary, removable markings that meet the following requirements:

a. Removability

Ensure the marking material can be removed from asphaltic and Portland cement as follows:

- Lifted intact or in large pieces.
- Lifted either manually or with a roll-up device.
- Lifted at temperatures above 40 °F (5 °C) without using heat, solvents, sand blasting, or grinding.

Ensure the pavement shows no objectionable staining or damage after removing the marking.

b. Elongation and Tensile Strength

Provide temporary markings with the following elongation and tensile strength when tested according to ASTM D 638:

Elongation	0.75 minimum
Tensile Strength	40 lbs/in ² (275 kPa) minimum

Test as follows:

- 1) Cut a 1 in by 6 in (25 mm by 150 mm) specimen.
- 2) Test at a temperature between 70 °F and 80 °F (21 °C and 27 °C).
- 3) Test at a jaw speed of 12 in/min (300 m/min).

c. Adhesion

Ensure that at least 10 lbs (20 N) of force is required to lift stuck-on marking material from the pavement.

d. Glass Bead Retention

Confirm the glass bead retention quality of marking material in both of the following ways:

1) Laboratory Test

- Take a 2 in by 6 in (50 mm by 150 mm) sample.
- Bend the sample over a ½ in (13 mm) diameter mandrel, leaving the 2 in (50 mm) side perpendicular to the mandrel axis.
- Ensure that the area on the mandrel shows no more than 10 percent of the beads entrapped by the binder less than 40 percent.

2) Field test

Ensure the beads cannot be easily removed by scratching the material firmly with the thumbnail.

e. Skid Resistance

Ensure that the material surface provides a 35 BPN minimum skid resistance value when tested according to ASTM E 303.

f. Thickness

Ensure that the removable marking material is at least 20 mils (0.50 mm) thick not including the backing adhesive.

2. Temporary Non-Removable markings (Type TN)

This type of pavement marking may use a conformable metallic foil backing with a precoated pressure-sensitive adhesive.

a. Abrasion Resistance

Use marking material that does not wear through to the backing surface in less than 125 cycles.

Test according to Federal Test Standard 141, Method 6192, using an H-22 wheel and a 250 gram load.

b. Skid Resistance

Ensure the retroreflective pliant polymer surface provides a skid resistance value of at least 35 BPN. Test according to ASTM E 303.

c. Elongation and Tensile Strength

No test for elongation and tensile strength is required for type TN marking.

d. Glass Bead Retention

Refer to Subsection 657.2.B.1.d, “Glass Bead Retention” for types TR and TN.

e. Thickness

Ensure the nonremovable marking material is at least 20 mils (0.50 mm) not including the adhesive backing.

C. Requirements for Permanent Markings (Types PA and PB)

1. Permanent Plastic Marking (Type PA)

Provide permanent plastic markings with these features:

a. Adhesive and Backing

Use markings supplied with the following:

- A precoated adhesive
- An easily removable backing to protect the adhesive
- An adhesive backing that allows repositioning of the marking on the surface before permanently sticking with greater pressure

In addition, supply rolls of lane lines with a precoated adhesive but without the protective backing material.

b. Pigments

1) White

Use white marking material with at least 20 percent of the total pigment consisting of titanium dioxide that meets Federal Specification TT-P442 for a dense opaque marking.

2) Yellow

Use yellow marking material with sufficient yellow pigment for a durable finished color.

In addition, match the yellow to the Highway Yellow Color Tolerance Chart and Chip 33538 of Federal Standard 595.

3) Appearance

Ensure that each marking meets the following appearance standards:

- Markings are extruded to a uniform thickness.
- Edges are smoothly cut and true.
- Glass spheres are retained on all sides by the plastic base material.
- The wearing surface is free of indentations, displaced spheres, or other irregularities that retain dirt, dust, or other foreign materials.

c. Thickness

Ensure the permanent material is at least 60 mils (1.52 mm) thick, without the pre-coated adhesive.

d. Glass Bead Retention

Confirm that the surface glass beads are strongly bonded and are not easily removed by traffic. Test them as follows:

- 1) Use a Taber Abraser with an H-18 wheel and 125 gram load.
- 2) Inspect the sample at 200 cycles under the microscope to observe the extent and type of bead failure.
- 3) Ensure that no more than 15 percent of the beads have popped-out.
- 4) Verify that the predominant mode of failure is “wear-down” of the beads.

e. Reseal Test

Test the plastic to confirm that it reseals to itself. Test as follows:

- 1) Cut two samples, 1 in by 3 in (25 mm by 75 mm) each, keeping the adhesive backing material in place.
- 2) Overlap these pieces face-to-face on a flat steel plate. The overlap area should be 1 in² (625 mm²).
- 3) Center a 1000 gram weight over the overlap area.
- 4) Place the sample in an oven for 2 hours at 190 °F ± 10 °F (88 °C ± 5 °C).
- 5) Cool the sample to room temperature.
- 6) Ensure the sample pieces cannot be separated except by tearing. Reject material that separates without tearing.

f. Tensile Strength and Elongation

Ensure that the permanent markings have the following elongation and tensile strength when tested according to ASTM D 638:

Elongation	75% minimum
Tensile Strength	150 psi (1035 kPa) minimum

Test as follows:

NOTE: Run this test 3 times and base the result on an average of the 3 tests.

- 1) Cut 3 specimens, 1 in by 6 in (25 mm by 150 mm) each.
- 2) Place 1 in² (625 mm²) of carborundum extra-coarse emery cloth or its equivalent at each end of the test specimens to prevent the adhesive from sticking to test equipment.
- 3) Test at a temperature between 70 ° and 80 °F (21 ° and 27 °C).
- 4) Test at a jaw speed of 10 to 12 in/min (250 mm to 300 mm/min).

g. Skid Resistance

Test the plastic surface to verify that it provides a skid resistance value of at least 45 BPN. Test according to ASTM E 303.

h. Abrasion Resistance

Ensure that plastic loses no more than 0.25 grams of weight in 500 revolutions when abraded according to Federal Test Method Standard No. 141 (Method 6192).

Test the material with calibrate H-18 wheels with a 1000 gram load on each wheel.

i. Adhesive Shear Strength

Ensure that the load required to break the adhesive bond is strong enough to resist a load at least 10 lbs (4.54 kg).

Test as follows:

NOTE: Run this test 3 times and base the result on an average of the 3 tests

1) Cut 3 specimens, 1 in by 6 in (25 mm by 150 mm) each.

2) Apply a 1 in by 3 in (25 mm by 75 mm) piece of carborundum extra coarse emery cloth or its equivalent to the adhesive face of each test strip. Overlap the area by 1 in² (625 mm²).

3) Apply 60 psi (415 kPa) of pressure over the overlapped area for 120 seconds.

Apply the load by gripping the ends of each laminated piece in a tensile test machine, such as a Dillon or Scott tester.

4) Run the test at 77 °F (25 °C).

5) Run the test at 0.25 in/min (64 mm/min).

2. Permanent Patterned Plastic Marking (Type PB)

Use patterned plastic markings with these features:

a. Patterned Surface

Ensure that the patterned surface has the following characteristics:

- A reflective layer of ceramic beads bonded to a durable polyurethane topcoat.
- The raised area comprises between 35 and 65 percent of the total marking face.
- The surface presents a near vertical face to traffic from any direction.
- The Office of Materials and Research approves the pattern configuration.
- The channels between raised areas are free of exposed beads or particles.

b. Adhesive and Backing

Refer to Subsection 657.2.C.1.a, “Adhesive and Backing” for Type PA.

c. Pigments

Refer to Subsection 657.2.C.1.b, “Pigments” for Type PA.

d. Ceramic Beads

Ensure that the top layer of ceramic beads is bonded to a durable polyurethane surface.

e. Ceramic Bead Retention

Refer to Subsection 657.2.C.1.d, “Glass Bead Retention” for Type PA.

f. Thickness

Ensure the materials are at least 60 mils (1.52 mm) thick, not including the pre-coated adhesive backing.

g. Reseal Test

Refer to Subsection 657.2.C.1.e, “Reseal Test” for Type PA.

h. Tensile Strength and Elongation

Refer to Subsection 657.2.C.1.f, “Tensile Strength and Elongation” for Type PA.

i. Skid Resistance

Refer to Subsection 657.2.C.1.g, “Skid Resistance” for Type PA.

j. Abrasion Resistance

Refer to Subsection 657.2.C.1.h, “Abrasion Resistance” for Type PA.

k. Reflective Intensity

Determine reflective intensity using photometric testing procedures of Federal Specification L-S-300 A, Paragraph 4.4.7. Reflective values are as follows:

	White			Yellow		
Observation Angle	0.2°	1.0°	1.05°	0.2°	1.0°	1.05°
Entrance Angle	86°	86.5°	88.8°	86°	86.5°	88.8°
Reflective Intensity--candle power per foot-candle per 5 ft ² (Candelas per Lux per square meter)	1.10	0.70	0.50	0.80	0.50	0.30

657.2.01 Delivery, Storage, and Handling**A. Marking Storage**

Use markings manufactured and packaged for storage at normal shelf temperatures for 1 year.

B. Contact Cement Storage

Use contact cements with a shelf life of 6 months.

657.3 Construction Requirements

General Provisions 101 through 150.

657.3.01 Personnel

Send a factory-trained representative from the material manufacturer to the jobsite at the start of each project.

657.3.02 Equipment

General Provisions 101 through 150.

657.3.03 Preparation

General Provisions 101 through 150.

657.3.04 Fabrication

General Provisions 101 through 150.

657.3.05 Construction

Remove existing pavement markings according to Subsection 653.3.05.B, "Removing Existing Stripe."

A. Pre-Conditions for Applying Markings

1. Meet the following conditions before applying markings onto new asphaltic pavements:
 - The ambient temperature is 60 °F (15 °C) and rising .
 - New asphaltic pavement temperature is at least 120 °F (49 °C).
 - The plastic can be applied to new asphaltic pavement immediately before the new surface is rolled for the final time.
 - Conventional steel rollers and water used with them do not impede the plastic's application.
2. Meet the following conditions before applying markings onto all pavements:
 - The ambient temperature is 60 °F (15 °C) and rising.
 - The pavement temperature is at least 70 °F (21 °C) and rising.
 - The previous night temperature did not fall below 40 °F (4 °C).
 - No significant rainfall occurred 24 hours prior to the plastic's application.

B. Remove Existing Stripe

Remove at least 90% of existing traffic stripe under either of the following conditions:

- On Portland cement concrete pavement where the new stripe is to be placed at the same location as the existing marking
- On all pavements where the new stripe is to be placed at a location different from the existing marking

C. Applying Markings

Apply markings as follows:

1. Thoroughly clean the pavement. Clean with compressed air, hand brooms, rotary brooms, scrapers, or other approved methods which leave the pavement thoroughly clean and undamaged. Remove all vegetation and road film from the area to be striped. Mechanically wire brush or abrasive blast clean all new Portland cement concrete pavement surfaces to remove all laitance and curing compound from the area to be striped.
2. Apply an adhesive activator according to the manufacturer's recommendations, when required.
3. Position markings according to the Plans.
4. Press positioned markings firmly onto the pavement.
5. Offset longitudinal lines at least 2 in (50 mm) from construction joints of Portland cement concrete pavements.

D. Tolerances and Appearance

1. Cut off all stripe ends squarely and cleanly.
2. The length of the 10 ft (3 m) segment for skip stripe and the 30 ft (9 m) gap between segments may vary plus or minus 1 in (25 mm). Do not allow the alignment of skip stripe to deviate from the intended alignment by more than 0.5 in (13 mm). Do not allow the alignment of edge stripe to deviate from the intended alignment by more than 0.5 in (13 mm) on tangents and on curves with a radius up to and including one degree. Do not allow the alignment of edge stripe to deviate from the intended alignment by more than 1 in (25 mm) on curves exceeding one degree.
3. Stop work when deviation exceeds the above dimensions, and remove the nonconforming stripe.

657.3.06 Quality Acceptance

Segments of preformed plastic traffic stripe that have been placed according to the Plans and Specifications may be accepted 30 days after the required work is complete in that segment. If Preformed Plastic Traffic Stripe fails to meet Plan details or Specifications or deviates from stated dimensions, correct it at no additional cost to the Department. If removal of pavement markings is necessary, perform it according to Section 656 and replace it according to this Specification. No additional payment will be made for removal and replacement of unsatisfactory striping.

657.3.07 Contractor Warranty and Maintenance**A. Warranties**

Transfer all warranties or guarantees normally furnished by the manufacturer to the Department. Include a provision that warranties are subject to transfer. Warrant Type PB Plastic Markings to adhere to the pavement and to provide a minimum coefficient of retroreflection of 0.10 candles per ft-candle per square foot (0.10 candela per lux per square meter) when measured at 1.0 ° observation angle and 86.5 ° entrance angle for a period of at least 6 years for longitudinal markings and at least 2 years for intersection markings and symbols under normal traffic conditions.

B. Maintenance

Use the following according to manufacturer's instructions to ensure effective marking performance:

- Solvents or adhesives
- Appropriate equipment
- Recommendations for application

657.4 Measurement

Preformed plastic pavement markings complete in place and accepted are measured as follows:

A. Solid Traffic Stripe

Solid stripe is measured by the linear foot (meter) or linear mile (kilometer) as specified. Breaks or omissions in solid lines and stripes at street or road intersections are not measured for payment.

B. Skip Traffic Stripe

Skip stripe is measured by the gross linear foot (meter) or gross linear mile (kilometer) as specified. The unpainted spaces between the stripes are included in the overall measurement, if the Plan ratio is not interrupted. Measurement begins and ends on a stripe.

C. Payment by Square Yard (Meter)

When preformed pavement markings are paid for by the square yard (meter), the number of square yards (meters) covered is measured. The space between the markings is included in the overall measurement. The color, width, and type are according to the Plans.

D. Preformed Plastic Word or Symbol

Each preformed plastic word or symbol, complete according to Plan dimensions, is measured by the unit. The code for each word or symbol is stated in the Plans.

E. Removing Existing Pavement Markings

Measurement and payment for removing pavement markings will be according to Section 656 when shown in the Proposal as a payment Item. Otherwise, removal will not be paid for separately, but will be included in the payment for other Work under this Section.

657.4.01 Limits

General Provisions 101 through 150.

657.5 Payment

Payment in each case is full compensation for applying markings, including adhesives, cleaning, application, and traffic control necessary to complete the Item.

Payment will be made under:

Item No. 657.	Preformed plastic solid pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per linear foot (meter)
Item No. 657.	Preformed plastic solid pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per linear mile (kilometer)
Item No. 657.	Preformed plastic skip pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per gross linear foot (meter)
Item No. 657.	Preformed plastic skip pavement markings_____ in (mm), (<u>color</u>), (<u>type</u>)	Per gross linear mile (kilometer)
Item No. 657.	Preformed plastic pavement markings	Per square yard (meter)
Item No. 657.	Preformed plastic pavement markings, words or symbols (<u>color</u>), (<u>type</u>)	Per each

657.5.01 Adjustments

General Provisions 101 through 150.

Section 659—Hot Applied Preformed Plastic Pavement Markings

659.1 General Description

This work includes furnishing and placing hot applied preformed plastic pavement markings according to these Specifications and at locations shown in the Plans or as otherwise directed. Use applied markings that are very durable, impervious to oil and grease, and provide immediate and continuing retroreflectivity. Use hot applied preformed plastic pavement markings that are compatible with existing alkyd and hydrocarbon thermoplastic material.

659.1.01 Definitions

General Provisions 101 through 150.

659.1.02 Related References**A. Standard Specifications**

General Provisions 101 through 150.